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Development of cork-wings on certain trees. II.

EMILY L. GREGORY.

ACER CAMPESTRE LINN.

Two kinds of Acer were examined, one, A. campestre, conspicuously winged till the stem is three or four years old, the other, *A. monspessulanum* Linn., much less, though the early part of its periderm formation is very similar to that of A. campestre. The development differs in both cases from that of Quercus, sufficiently, perhaps, to warrant a brief description.

Of Acer campestre, the young stem is six-angled, the periderm forms uniformly around this, by the cells of the first layer of primary rind becoming phellogen and developing centripetally[13] just as in case of Quercus. The breaking takes place along the six angles, the subsequently increased rapidity of growth under these fissures occurs, but with this difference, there is no line of distinction between the cells of the periderm formed previous to the splitting along the angles, and those of the wing formed by the renewed energy of the phellogen under these fissures. Instead of five, as in Quercus, there are six longitudinal bands growing faster than the remaining six; this continues till a furrow is formed along the top of each wing, making a similar shell-shaped appearance on the cross section as in Quercus. (See fig. 11.) Now very early in the development of the wing, the cells of the remaining six bands begin to grow and increase more rapidly than those of the former six, thus the central portion of each furrow is forced out until the edge of the wing is perfectly straight, in most instances no signs of the furrow being left. There is now no difference in the appearance of the cells of the entire wing. Toward the end of the summer, or the beginning of the fall growth, there are six strongly developed wings, the clefts between each two successive ones reaching quite down to the phellogen layer. The cells of the remaining epidermis have been so protected by this

[13] Centripetal is used here as by Sanio, in the sense that the newest tangential wall is nearest the center of the stem.

breaking in fissures and subsequent curling up, that not unfrequently the hairs from this tissue are seen along the smooth surface of the wing. This is shown in figure 11.*a*. As the autumn growth begins, several layers of narrow plate cells are formed entirely around the stem and it now takes its winter's rest. In the following spring, the manner of growth seems to vary. In most stems examined the process was quite similar to that of Quercus, the entire zone of phellogen cells developing rapidly till the protecting band of thicker walled plate cells breaks at the fissures and the new growth forces outward the last year's wings. This rarely, if ever, continued longer than till the third year; the growth of the three years' stems, as well as many of the two years', being as follows: As the girdle of plate cells breaks, the increased growth in circumference of the entire rind cells appears to take place most rapidly in sections under the fissures, or between the wings of the first or second year's growth. The periderm cells are formed more or less uniformly, but the foundations are laid for new wings between those already formed. In this way six more wings are formed, and not many seasons after this, the stem assumes the ordinary ridged and furrowed appearance which is no longer described as winged. Thus the transition from wings to ordinary furrowed periderm takes place. This method of transition is carried still further in

ACER MONSPESSULANUM L.

The stems of the second and third year of this species can hardly be called winged, though the periderm growth of the first year corresponds to that of Acer campestre. That of the second year is similar to the third and fourth of the stems of the former. Little wings are formed between those of the first year so rapidly that a fissure occurs along the edges of these during their first year's growth; that is the second year of the stem. (See fig. 14.*f*.) The result of the repetition of this process is the formation of a periderm around the older branches with rather shallow and irregular furrows and by no means prominent ridges. This species thus may be considered a transition form between the regular cork wings of A. campestre and the comparatively smooth periderm on the young branches of the common maple.

LIQUIDAMBAR STYRACIFLUA L.

The cork wings found on this tree have one striking peculiarity which renders them an exception to all other cases

examined. This is their eccentric or one-sided origin and growth. In this respect the species seems to stand quite alone. The specimens examined in the summer of 1887 were taken from trees of various ages and places of growth, all of them were under cultivation and all in the vicinity of Philadelphia, except those from the Arnold arboretum. In the summer of 1888, examples were obtained from trees of different ages growing wild near Woodbury, N. J. The results obtained from these, while confirming in most respects those obtained from the specimens of the previous year, were much more satisfactory, as the young tree in its early stages, up to those of fifteen years old, could be observed under natural conditions. The wings of the lateral branches appear always on the upper side, running along between the leaves, two, three and sometimes four in number. They generally stand at such an angle as to form troughs along the entire length of the branches. These are, of course, interrupted at the nodes by the leaf-petioles, but they slope gradually toward each other, so that the effect of a continuous trough is often produced. The main trunk is entirely surrounded by deep ridges and furrows along that part free from branches, and extending up perhaps half way through the crown of the tree. Above this a smooth periderm appears. A large number of specimens were studied, with a view of discovering the cause of the one-sided growth on the lateral branches.

The principal results of the anatomical study may be given in few words.

The first appearance of periderm formation occurs early in the year, but in most cases the youngest internodes of the year's growth are covered only by epidermis. The phellogen cells are in this case the second layer from the epidermis, so there is one layer of rind cells cut off, as de Bary says of a similar case, without wings, "for a very small bark." Lenticels are developed with this first periderm in considerable numbers. On the lateral branches at the time of the beginning of the cork wings, they are much larger, better developed and somewhat more numerous on the upper than on the under side of the stem. With this exception, the growth appears perfectly normal, a periderm of several layers is developed around the stem with lenticels connecting the rind cells with the outer air. After a time, along the upper side of the older internodes of this year's stems may be noticed an increase in the tissue around the lenticels. This may be easily identified by the naked eye as cork tissue from

its color, which is slightly reddish, and different from the rest of the surface. This is the first beginning of the wing; the tissue soon spreads from one lenticel to another until a ridge is seen extending along the upper surface of the internode. It is not possible to say that the wing always takes its rise from the lenticels, in this way, as instances of its origin between the lenticels, then spreading out so as to include them afterward, may have been overlooked. No such cork tissues were found entirely disconnected from the lenticels. Another fact pointing to the lenticellular origin of the wing is, there were several examples, where, for some lack of favorable conditions, the wing formation had stopped with the growth of cork immediately under the lenticels in such a manner that a number of these, lying in almost a straight line on the upper side of several successive internodes, were raised up from the surface for a distance of one or two millimeters. Usually there was only one ridge of cork at first; often, however, there were several smaller ones branching off, so that when developed a number of wings stood out at different angles.

The manner of growth of this tissue does not differ essentially from that of the previously described type. The phellogen layer in the vicinity of the lenticels becomes endued with unusual vitality; cells are cut off centripetally, and by this means the lenticel is raised up or away from the rind, a large number of cork cells intervening between it and the rind-cells. The opening of the lenticel now takes the place of the fissure made over the corner of the angular stem of Quercus and Acer above described. As the epidermis is raised up along the band, the longitudinal fissures already existing in the lenticels spread from one to the other until a continuous cleft is made along the whole internode. In this way are laid the foundations for two wings, which appear to be the normal number. In many cases, however, the development about each lenticel takes place in such a manner that instead of one connected line along the internode, several are formed; these often join each other at different points so that closed furrows are formed, the number of ridges, or wings, thus being increased to three, four, and even five; in the last case they nearly encircle the stem.

In those wings breaking along the openings of the lenticels, which have been described as normal, there occurs also another break which separates the wing from the remaining tissues. This is a break along the edges of the band of corky

tissue where it joins the regular periderm. This is shown in fig. 15, *b*. This breaking is prevented at first by the cells along these lines forming new walls at such angles as to form a fan-like spreading, large enough to accommodate the rapidly growing wing. The rapidity of growth, at first greater in the center of the wing, appears to gravitate toward the edges, and the break occurs. Both sections of the wing are now free to be shoved out by the rapidly growing phellogen. In the meantime the fissure in the middle, originating from the lenticel opening, increases till it reaches in many cases quite down to the primary rind. Toward the fall, about the middle of September in the examples studied, there are formed several layers of plate cells, extending around the whole stem. When growth is resumed in the following spring, the formation of cork is limited strictly to the phellogen under the wings; its rapid growth breaks the bands of plate cells and new layers are formed, pushing outward the growth of the previous year. As long as the vitality remains principally in the phellogen cells under the wings, this process is repeated each year; the breaking which takes place on renewed growth in the spring follows the lines already started, and the age of the stem may be estimated as surely by the number of broken bands of plate-cells along the edge of the wing, as by the number of woody rings on the other side of the cambium ring. The material for this study was very abundant, and a large number of specimens was examined: among them all was only one case in which the number of annual layers of cork did not agree with the number of woody layers of the stem. In this instance six rings of cork were found, where only three of wood could with certainty be detected. It is impossible to say, in this case, whether two rings of cork had been added each year, or whether the annual marking off of the wood had failed in the later years of growth, as the last ring of wood which was plainly marked off was about the width of both the other two. On many branches whose woody growth is not very rapid, these cork wings reach a comparatively enormous size, often measuring in depth twice and three times as much as the diameter of the remaining part of the stem. Some have been found fully three centimeters in depth, and one and a half centimeters is not an uncommon size. These large wings, when found on lateral branches, occur in most cases on stems which have closed their growth in length. Those stems whose growth in length is prolonged from year to year till

they form the main branches of the crown, begin, when young, to develop wings in the ordinary manner, and continue doing so for six or eight years. Then on the older internodes the development under the wings becomes less and less in amount; the ordinary periderm accommodates itself to the increasing size of the surface of the other parts of the stem, that under the wings apparently remaining stationary, until it is highly probable in many cases the growth of the wing entirely ceases and the phellogen of the entire circumference resumes its function of uniform growth, and the wings are slowly cracked off. However this may be, many of the larger stems appear to be covered with a nearly smooth periderm, and many others are nearly smooth at the place where they join the main trunk, while further on toward their extremities they are profusely covered with wings.

Now taking the growth of the main stem from its origin, a young tree, three years old, was cut off about one and a half feet from the ground. At this height the circumference was nearly covered with the cork wings, but by looking carefully it could be seen there was still a distinct longitudinal strip or band which was yet free from this growth except under the lenticels. This was more and more easily traced as one looked upward, until the last year's shoot which showed the typical one-sided formation. So with the oldest internodes of this year's growth; date, July 16. The whole length of this year's growth of main stem was forty-six centimeters; the lower thirteen centimeters had well-developed cork wings, above this none had yet appeared. Lateral branches growing out from this portion of the main stem were also supplied with wings on their older internodes. It is easy to see how the whole bole of the tree probably becomes covered with its ridged and furrowed periderm. In the tree just described, the longitudinal strip or band along which ran no regular wings was already supplied with corky tissue at the lenticels, raising these slightly from the surface. The phellogen cells of this tissue probably soon after the third or fourth year become endowed with special activity; the layer is extended from lenticel to lenticel, just as in the first year's growth, till at last connected ridges are formed, more or less irregular in their course, as the lenticels have no regular order of arrangement. These ridges assume, after a few years, an appearance entirely similar to those of the first year's growth. In fact, intermediate stages appeared already present where the lenticels appeared in cer-

tain stages, leading to the final result of covering the whole trunk of the tree. Ridges from a tree of fifteen years were broken off about four feet from the ground. The annual deposition of corky substance was seen here to diminish as the tree grows older, the later years' rings being much narrower than the earlier ones.

Biological Dep't, Univ. of Penn.

Botany at the University of Göttingen.

W. E. STONE.

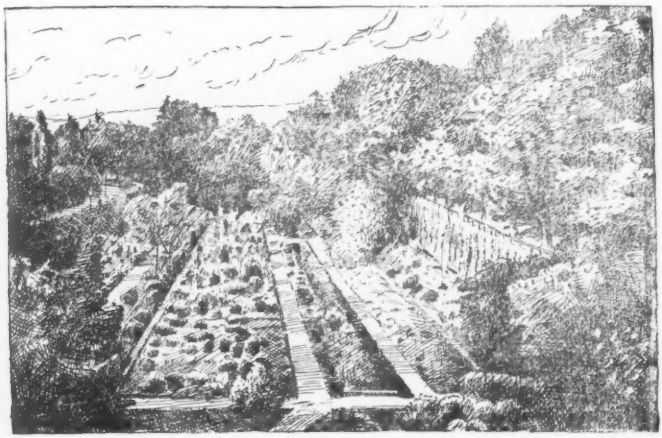
The botanical department of the University at Göttingen, of which I have been requested to write a description, has never been particularly famous, yet has won and retained an excellent reputation in Germany for its good work and favorable advantages. Persons whose experience warrants the expression of an opinion, consider the arrangement of the laboratory to be equalled by few others in Europe, while the garden is notably well stocked and cared for. For the latter much credit is due Prof. Graf zu Solms Laubach, who for many years was director of the same and professor of systematic botany. In the spring of the present year he received almost simultaneous calls to the Universities at Strasburg and Berlin, accepted the former, and now occupies the chair of deBary.

There is a tacit division of the work here into the physiological and systematic departments, each presided over by different professors, and each with its own laboratory, branch library and lecture room.

The present director of the garden and professor of systematic botany is Dr. Peters, formerly a student and assistant with Nägeli. His work upon the genus Hieracium has secured him special notice. He was called to Göttingen from Munich, to take the place of Prof. Solms Laubach.

The garden, which is one of the sights of the not remarkably interesting old town, occupies, roughly estimated, five or six acres of ground, lying partly within and partly without the old "wall." The latter is no longer the defense for which it was planned and built some three or four hundred years ago, but has become a pleasant elevated promenade with grassy slopes and planted with a double row of fine old

lindens, beneath which one always meets a procession of promenaders on pleasant summer afternoons and evenings. For a part of its winding course, as I have said, it traverses the botanical garden, looking down to the south side upon the dwelling of the director and gardener, the green-houses and the collections of tender plants, thus protected from the cold north and east winds. On the other, the north side, are the more extensive collections of hardy plants, trees and shrubs, arranged to some extent systematically, especially



BOTANICAL GARDEN AT GÖTTINGEN.

the herbaceous plants. The principal entrance to the garden is from one of the streets of the inner town. Passing the pleasant old-fashioned houses of Director Peters and the gardener, one comes out upon a fine lawn fronting the three large green-houses, behind which rises the sheltering "wall." Close beside the director's house a large three-story brick building is rising, which, when the slow-but-sure German building process shall be completed, will serve for a "systematic" laboratory, herbarium, and auditorium. Upon the lawn are grouped in summer the potted shrubs and hardier plants from the green-house, tree ferns and palms, giving the little space a decided tropical aspect. Here, too, is an excellent collection of Azaleas, and near by in a shady, moist nook are the native orchids.

Two tunnels pierce the "wall" and bring one out on the other side into a different flora—that of the temperate zone. In the foreground runs a little stream, moistening a bit of meadow turf and supplying a basin for aquatic and marsh plants. Behind this rise low terraces neatly and systematically laid out in beds for herbaceous plants, where naturally the Compositæ preponderate. On the west side of this part of the garden stands the finest building of the University, from the upper windows of which the view given here is taken. Toward the east rise masses of trees, behind which, with an entrance from the street, stands the physiological-botanical laboratory. Still farther toward the east are open spaces devoted to the collections of grasses and sedges, the Liliaceæ, Araceæ, etc.

Altogether the garden, partly from natural location, partly from the influence of the "wall," furnishes a remarkable variety of exposure and adaptation rarely met with upon so small an area. I have seen no botanical garden better kept than this; there are absolutely no waste spots, although spontaneous natural growths are allowed in some places.

The herbarium is said to be a good collection, but, as is often the case in these days, lacks attention, and is simply stored away in the upper story of one of the garden buildings, inaccessible and unused. The intention is, however, to have it properly arranged and made available in the new building being erected. The physiological laboratory is under the direction of Prof. G. Berthold, one of the youngest full professors in the University, his early promotion being the recognition of his energy and ability. His career was begun here as "privat docent"; afterwards he was assistant to the director of the zoölogical station at Naples, where he published several monographs on the marine algæ. He became "ausserordentlicher" professor at the university of Göttingen in 1885, and full or "ordentlicher" professor in 1887. His principal work, aside from numerous contributions to journals, has been "Studien über Protoplasma Mechanik," a profound production published in 1887. Prof. Berthold's relations to his students are of the most pleasant nature. He is a hard worker, taking short vacations, and almost invariably to be found during working hours in his private laboratory, from whence at short intervals he visits his students working in the main laboratory, greeting each with some pleasant word of advice and encouragement. The assistant, Dr. Koch, with whom the students come directly in contact,

was a pupil and assistant of deBary. His greatest horror is untidiness, of which fact no student is likely to remain long unacquainted.

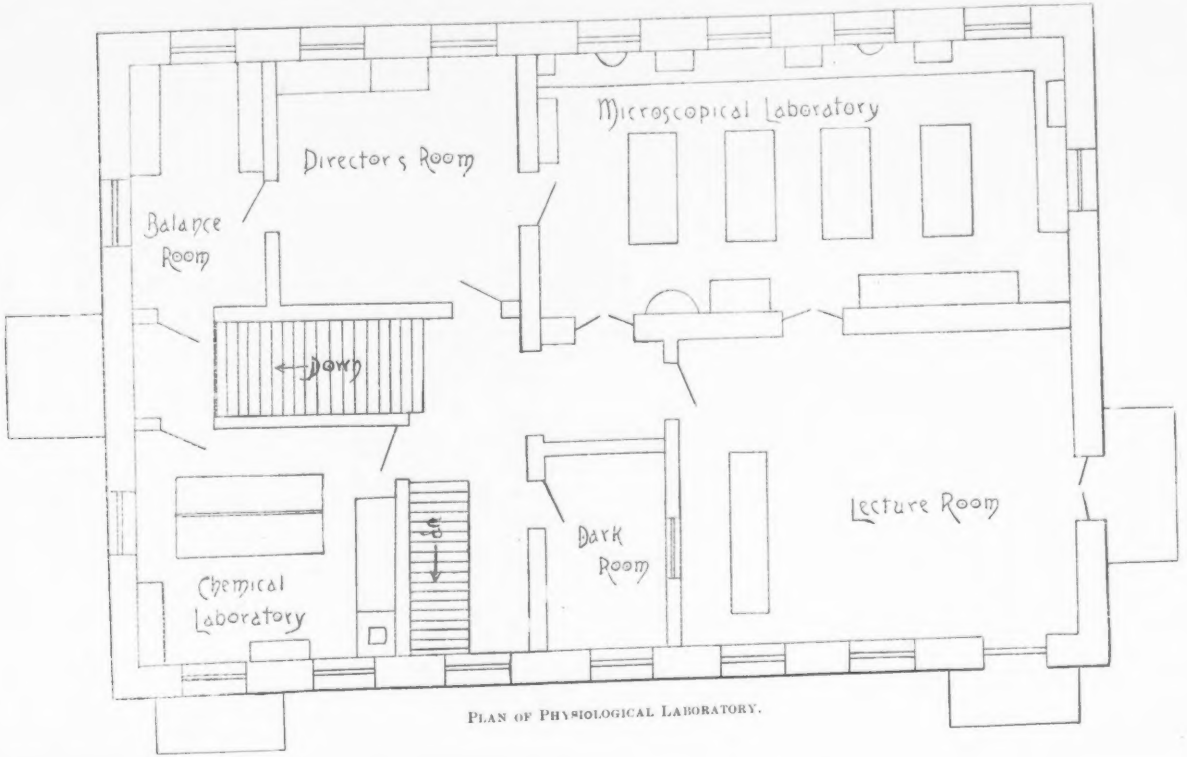
My two years' connection with these men leaves me with a lively and grateful appreciation of their worth as friends and teachers which I can not omit expressing here.

The physiological laboratory is a very substantial two-story stone building with rather plain exterior. The view given is taken from the south or garden side. The ground floor is occupied in part by the janitor's family, a common

LABORATORY FOR VEGETABLE PHYSIOLOGY.

custom in the University buildings, and by a museum, physical cabinet and physiological laboratory. There is also a workroom on this floor containing a still, forge and table for glass blowing. In the cellar are rooms for gas analysis, temperature experiments, etc. The main working rooms of the laboratory are on the second floor, a plan of which is here given.

The main rooms are directly accessible from the stair landing. First on the left is the director's private laboratory with its independent outfit, working table before one of the windows, water, gas, ventilating hood, aquaria, etc. A door opens into the main laboratory, a large, well lighted room with five windows of $4\frac{1}{2}$ by $8\frac{1}{2}$ feet dimensions, looking out toward the north and east, and affording a fine illumination for microscopic work. There are places here for thirty students, ten for advanced workers directly before the win-



PLAN OF PHYSIOLOGICAL LABORATORY.

dows at benches provided with drawers, closets, cases, reagents, water and gas. Twenty more students, engaged with simpler work, find places at four large tables arranged through the middle of the room. A cabinet for microscopes, a case for reference books, shelves for specimens, a "*Brutofen*" for the reception of cultures, completes the furnishing of the room. Adjoining, on the south side of the room, is the auditorium, which, as a lecture room, accommodates fifty hearers, or by removal of the portable benches can be used for experimental purposes. Two of these windows are really glass doors opening to the east and south into glass-covered balconies used for the reception and cultivation of plants for lecture demonstration. In the southern one is a small glass forcing house, or more properly box, capable of being heated by gas, and provided with a thermo-regulator. The lecture table is also arranged as an experimental table and provided with gas, water and an air-pump. The room may be effectually darkened for experiments with light. In this connection, the sliding black-board behind the table reveals an opening into the "dark room" well supplied with optical apparatus, by means of which light of varying quality may be transmitted to the experimental room. This arrangement also allows the most convenient use of the stereopticon for class demonstration. The remainder of the south side of this floor is occupied by the chemical laboratory with complete apparatus and accommodations for four workers, with water, gas, steam drying bath, sink, two large hoods, combustion furnace, muffle, etc. Here again a glass door opens upon a glass-covered balcony for the reception of plants under observation. From this a second balcony is entered, which, thus cut off from the remainder of the building, is used for the generation of noxious gases.

From the chemical laboratory a gallery leads over the stairway to the balance room; from it a side door also opens upon a large open balcony over the entrance to the building, with a western exposure—a convenient place for growing and maintaining potted plants in summer.

The balance room is supplied with a fine Sartorius' chemical balance, and a large balance for the reception of growing plants weighing from 0.1 to 15,000 grams. The same room contains the reference library, and is also accessible from the director's room.

From the landing another staircase leads to a physiological work-room under the skylight, and there are one or two

store-rooms also on this floor. Last, but not least, is a small work-shop for the janitor, who is an excellent mechanic and makes nearly all the apparatus and models required in the institute.

A noteworthy feature is the double water supply, two complete systems of pipes leading to all points of the building, one for the city water, which contains so much lime that it is unfit for general laboratory use, and one for rain-water, collected from the roof and stored in a reservoir on the third floor. The systems are interchangeable, and both may be used for either rain or "city" water.

The building is new, having been first occupied in 1879, and was intended to embody the best features of the best botanical laboratories known at the time. A full discription of its plan and erection is given in the *Botanisches Centralblatt*, V. (1881) pp. 318, 349, 388.

In this, as in most of the German universities, the greater part of the botanical students are derived from the medical and pharmaceutical departments, a knowledge of botany being required in the examinations in both these branches. For these students lectures and work of a general nature are provided, but there were always, during my acquaintance with the department, a comfortable number of advanced students engaged on theses and "arbeits."

I give here, also, the titles of lectures given during this time: Anatomie der Pflanzen, Fortpflanzungs und Befruchtungserscheinungen, Ueber das Protoplasma, Ueber Gymnospermen und Archegoniaten, Palæophytologie, Ueber Pflanzenkrankheiten, Grundzüge der Botanik, Vegetation des Meeres, Ueber der Thallophyten, Ueber Nutz und Arzneigewächse. Besides these, lectures were given in the agricultural department on plant nutrition, growth, etc., also of botanical interest. Some of the lectures were free courses, representing the latest work of the professor on some special subject. Some were attended by fifty or seventy-five students, others by four.

In summer there are usually one or two excursions weekly to points of botanical interest, which often means a short railway journey and always a hard tramp. Professors and students are then at their best, unreserved and jolly, striding away across the fields often in disregard of the law requiring pedestrians to keep to the beaten paths, until some irate peasant halts the party, and the young fellows, with winks

and nudges among themselves, watch the professor banter with Hans. Then, when the masquerade is revealed, "Donnerwetter" changes to "Entschuldigen Sie," and all is well, although it sometimes happens that nothing but the payment of the regular three marks' fine will secure the peaceful and undisputed progress of the expedition. An unfailing feature is the halt for lunch at some convenient "Gasthaus," where, over black bread and sausage and mugs of foaming beer, many an interesting botanical question as well as jolly joke or story is discussed. If a part of the excursion is by rail, tickets are taken third class, and even these are obtained, in such cases, at reduced rates.

At play or at work I have found the German professors and students wholly interested and in earnest. Perhaps thus their work obtains a character of reliability and thoroughness; perhaps thus they are able to derive such satisfaction from the most minute and tedious investigations and inspire in new students such enthusiasm and devotion. Certainly, working or playing, I was glad to count my connection with the botanical people at Göttingen among the pleasantest of my university experiences.

Amherst, Mass.

Notes on Andropogon.

F. LAMSON SCRIBNER.

Prof. E. Hackel, in his contribution (Gramineæ) to Engler's great work on the families of plants (Die Pflanzenfamilien), has extended the genus Andropogon so as to include a number of grasses which have been for some time regarded as belonging to distinct genera. The genus is divided into 12 subgenera, among which are Sorghum, Chrysopogon and Heteropogon. Based on this classification, Prof. Hackel recognizes 25 species as belonging to the United States. The following is the list in full, kindly furnished me by Prof.

Hackel in advance of his "Monographia Andropogonearum," which is now in press, and will be published next year:

1. A. semiberbis Kunth.
2. A. hirtiflorus Kunth.
   subvar. oligostachyus Hack.
   subvar. feensis Hack.
3. A. cirratus Hack.
4. A. tener Kunth.
5. A. scoparius Michx.
   subsp. genuinus Hack.
   (There are no other varieties distinguished, but some forms are named.
   subsp. maritimus Hack.
   var. *a.* maritimus (S. States).
   var. *b.* divergens (Texas).
6. A. gracilis Spr.
7. A. macrourus Michx.
   a. genuinus.
   b. abbreviatus Hack.
   c. hirsutior Hack. (vaginis tuberculato-villosis, Mobile, leg. C. Mohr).
   d. corymbosus Chapm.
   e. glaucopsis Chapm.
8. A. Virginicus L.
   a. genuinus Hack.
   with subvar. stenophyllus Hack.
   b. glaucus Hack.
   c. dealbatus Hack.
   d. tetrastachyus Hack.
9. A. Leibmanni Hack.
   var. *b.* Mohrii Hack.
10. A. longiberbis Hack.
11. A. Elliottii Chapm.! (non A. vaginatus Ell., sed A. clandestinus Hale.
12. A. brachystachyus Chapm.
13. A. arctatus Chapm.
14. A. argyreus Schult.
15. A. Cabanisii Hack.
16. A. provincialis Lam.
17. A. Hallii Hack. (cum var. flaveolus, incanescens, muticus).
18. A. Wrightii Hack. (Wright, New Mex. coll. no. 2104).
19. A. saccharoides S. W.
    var. Torreyanus Hack
    var. submuticus (Texas, leg. Nealley).
    var. perforatus (A. perforatus Trin. Texas, Berlandier, no. 641, Lindheimer no. 1161).
20. A. Sorghum Brot.
    subsp. halapensis Hack. (Sorghum sp. Pers.).
    subsp. sativus (cultivated sorghum, the varieties of which are very numerous).
21. A. nutans L. (with vars).
22. A. unilateralis Hack. (Sorghum secundum Chapm. This can not be named A. secundus in consequence of A. secundus. Willd.)
23. A. pauciflorus Hack. (Sorghum pauciflorum Chapm., but it is not of the Sorghum section, but belongs to Chrysopogon).
24. A. contortus L. (Heteropogon sp. R. & S.).
25. A. melanocarpus Ell.

The changes in Patterson's Catalogue, following from this arrangement are as follows:

Andropogon dissitiflorus Mx.=A. Virginicus L.: A. Mohrii Hack= A. Leibmanni, var. *b:* A. saccharoides S. W., var. inermis Vasey= var. submuticus Hack.: the var. maritimus under A. scoparius is raised to a subspecies: Chrysopogon nutans=A. nutans L.: C. secundum=A. unilateralis Hack.: C. Wrightii=A. pauciflorus Hack.: Heteropogon acuminatus=A. melanocarpus Ell.: H. contortus=A. contortus L.: Sorghum halapense=A Sorghum Brot., var. halapensis Hack.

There are some new varieties; other varieties reduced to forms; and others wholly omitted.

In the letter communicating the above list of Andropogons (dated June 10), Professor Hackel says: "As to other Andropogoneæ, there are some changes in nomenclature, viz.: Imperata brevifolia Vasey is I. Hookeri Rupr.: 'Elionurus candidus' from Texas and Arizona is not E. candidus Hackel in Flor. Brazil., but a new species named E. barbiculmis: 'Elionurus Nuttallianus' of Vasey, Grasses of the U. S., is the type of E. tripsacoides HBK.: Rottbœllia corrugata Baldw. is recognized as a species, with the variety areolata: R. tesselata Steud. is a form of R. corrugata: R. rugosa has a var. Chapmani (Curtiss, no. 3622)."

Washington, D. C.

Notes on the inflorescence of Callitriche.[1]

JOSEPH SCHRENK.

While examining the flowers of *Callitriche heterophylla* Pursh, I noticed some peculiarities about the so-called *bracts* of the inflorescence which seem to have escaped notice thus far.

For the sake of completeness I will briefly state that the species examined has dense floating tufts of broadly spatulate opposite leaves, each bearing in its axil one, sometimes two pistils, and one stamen[2] between a pair of the bracts mentioned. The latter are of a semilunar shape, attached by one of the attenuated ends to the stem, the concave sides turned toward the pistil.

Of such bracts, including those met with in other families, Hydrilleæ, Naiadeæ, Potameæ, etc., H. Schenck, in his elaborate paper on the "Comparative anatomy of submersed plants,"[3] says: "These structures are no stipules, as Caspary calls them, but true trichomes. They are found in the axils of the leaves in the form of tender, transparent, roundish or elongated, small scales, consisting of one or two layers of cells. They originate early at the apex of the stem, develop more rapidly, and perish sooner than the neighboring leaves. Probably they all produce a secretion which en-

[1] Read before Section F, A. A. A. S., August 16, 1888.

[2] In the numerous specimens examined I noticed that when there were two pistils in one axil the stamen was invariably wanting.

[3] Bibl. bot., Vol. I, 1887, p. 10.—The "Monograph on the genus *Callitriche*," by Fr. Hegelmaier (1864) I was unable to consult, and had to be satisfied with the statements of Schenck (l. c.) and de Bary (Comp. Anat.) referring to it.

velops the growing apex." This paragraph refers to the following passage on the preceding page: "Most likely this secretion protects the meristematic apex and the young leaf buds against parasites, etc., but for the present we can not insist on the correctness of this explanation."

A close inspection of the structures in question will show that they are not simple scales or trichomes, but small bladders or sacs. When held under a lens, in air, they might easily be mistaken for flat scales, but when examined with a low power in the fresh condition, under water, they are invariably found to be filled with air, and thus they can be recognized as bladders without difficulty. That the air is really inside the sacs can also be readily demonstrated by gently warming the water on the slide on which they are placed, when they will be seen to expand considerably. When the sacs are placed in boiling water, the air is at last driven out. This is, in fact, the most convenient way to get rid of the air, for even after long continued treatment in alcohol air bubbles will still remain in the sacs.

Under higher powers the surface view and sections of the bladders show that their wall is a thin membrane formed of a single layer of transparent, elongated, flat cells with very sinuous side walls. Inside of the bladder a slender thread can be distinguished, which projects from the base into the cavity. It consists of two or three rows of long, wavy cells laterally connected by short branches.

At the meristematic apex of the stem, on the youngest node, the sacs are found as small protuberances alongside the rudimentary pistil. They consist of the epidermis, which bulges out in the angle between leaf and pistil, and covers only a few rounded cells that belong to the meristematic interior of the apex. At the next lower node these excresences are much larger. The epidermis cells still have a rounded outline, while the few enclosed cells begin to elongate perceptibly. Examining still older nodes we find that the development of the sacs has been completed. The cells of its wall have increased rapidly in number and size, and have assumed the wavy outline peculiar to so many epidermis cells. The growth of the cells which originally filled the sac has not kept pace with its surface growth, and they have remained as a contorted and isolated thread in the interior of the sac, while the walls have receded and expanded.

Thus a hollow plant organ is formed by schizogenetic

growth, which it is impossible to designate a "trichome," for it is evidently not merely an outgrowth of the epidermis. On thin longitudinal sections the continuity of the air-spaces in the larger air-channels of the internode, in the intercellular cavities of the node, and, finally, in the interior of the sacs, can be traced distinctly. I would, therefore, call these sacs, not trichomes, but reduced, or rather transformed phyllomes, transformed in order to fulfil a special function, *i. e.*, to give the apex of the stem necessary buoyancy, so that the leaves may receive light and air, and the pistils and stamens the visits of insects or the currents of the air.

At no stage could any secretion exuding from the sacs be noticed. The protoplasm contained in the cells, although plainly visible at the early stages, is too insignificant to indicate that intense activity which is going on in secretory organs; besides, the comparative isolation of the cells, which are really simply epidermis cells, speaks against such a function. But I would call attention to the peculiar fan-shaped, or rather palm-shaped hairs[4] found at the nodes in considerable numbers, which most likely produce some kind of secretion. Their walls are filled with dense, granular protoplasm, and are quite thick, presenting on the addition of reagents the peculiar appearance of mucilage-producing membranes. Besides, the fact that they are found fully developed at the very apex of the growing stem, when all the other organs, the sacs included, just begin to differentiate, leaves hardly any doubt that they serve for the protection of those points that are most in need of it.

For systematic botany the question is of great interest, whether each, the pistil and the stamen of Callitriche, is to be considered a separate flower or not. In most text-books[5] the flowers are described as monœcious. In my opinion, the histology of the inflorescence ought to decide the question.

On a longitudinal median section of the stem, through a young node, we see a central fibro-vascular bundle which receives additional strands of vessels on both sides from the leaves. In each of the two angles thus formed there arises a vascular bundle which, after proceeding a short distance, separates into two slender branches; one of them, the one nearer to the leaf, leads to the pistil, and the other, the upper

[4] Cf. DeBary, Comp. Anat. Engl. ed., p. 64.

[5] *e. g.*, Gray's Manual, Eichler's Syllabus.

one, to the stamen. The other tissues of pistil and stamen are arranged correspondingly, so that, *e. g.*, the epidermis of the filament and of the short pedicel of the pistil are a continuous layer of cells.

There is no reason why, under these circumstances, we should separate these two organs and call them two different flowers, when, in fact, they could not be any more closely connected than they really are.

Hoboken, N. J.

Undescribed plants from Guatemala. V.

JOHN DONNELL SMITH.

(WITH PLATES XXIII and XXIV.)

VOCHYSIA GUATEMALENSIS. Bot. Gazette, XII, 131. Explanation of Plate XXIII: Fig. 1. Flowering branch—natural size. Fig. 2. Immature capsule. Fig. 3. Flower. Fig. 4. Same with pistil exposed. Fig. 5. Staminode. Fig. 6. Stamen. Fig. 7. Anterior petal. Fig. 8. One of the lateral petals. Fig. 9. Vertical section of ovary. Fig. 10. Ovule. Fig. 11. Diagram of flower. (Figs. 3–11 are variously enlarged.)

Hanburia parviflora.—Leaves roundish, base emarginate, 5–6 inches long, 5-times exceeding petiole, triplinerved, tripartite nearly to base, divisions oblong-lanceolate: shortly peduncled racemes 12–15-flowered, flexuose, nodding, twice exceeding petioles, spreading pedicels equalling flowers: calyx urceolate-campanulate, 6 lines long, nearly half as broad, teeth minute: corolla-segments ovate, half as long as calyx, reflexed: filament-column 4 lines long, antheriferous globose-turbinate head 2 lines broad, cells in 10–12 pairs: pistillate flowers not seen.—The other species of this genus, *H. Mexicana* Seem., has long-petioled uniformly undivided leaves exceeded by peduncles of rigid racemes, sparse twice-larger flowers, a shortly campanulate calyx, anther-cells in more numerous lines.—Pansamalà, alt. 3,800 feet, April, 1888. (Ex Pl. Guat. Tuerckh., qu. edid. J. D. S., 1366.)

Calea trichotoma.—Branches divaricate, fusco-tomentose: leaves petiolate, 12–18 lines long, subcordate, triplinerved, remotely serrulate, scabrid above, cano-tomentose beneath: pedicels of simple or compound terminal corymbs 3, half an

inch or less long, monocephalous: heads homogamous, about 20-flowered, subglobose, 5 lines high; exterior bracts of involucre foliaceous, scabrid, ovate, minute; interior ones smooth, oblong, obtuse, exceeded by disk; bracts of conic receptacle conduplicate, laciniate, rostrate: palets of pappus 20–23, linear-tapering, nearly naked, subequalling corolla; achenia pubescent.—Nearest, especially in foliage, to the Columbian *C. glomerata* Klatt., Bot. Jahrb. VIII, 45. Rocky mountain sides near Coban, alt. 4,300 feet, Aug., 1887. (Ex Pl. cit. 1353.)

PITCAIRNIA TUERCKHEIMII. Bot. Gazette, XIII, 190. Explanation of Plate XXIV: Fig. 1. Plant, nat. size. Fig. 2. Vertical section of flowers nat. size.

Baltimore, Md.

BRIEFER ARTICLES.

Œnothera albicaulis.—The order Onagraceæ contains many interesting and beautiful species and this species is not the least deserving of notice. The flowers are large, white at first, later turning to a delicate rose-color, and very conspicuous. One evening during July I was walking with a gentleman from the barn to the house. We passed along the edge of a kitchen garden, and when near the house I called his attention to a large patch of Œnothera albicaulis which had never known the hoe. He admired the flowers, remarking that they were worth cultivating for ornament. We had not gone ten yards beyond them when a most offensive, sickening fœtid odor assailed our nostrils. At first we could not account for it, because we knew of no carrion in the vicinity. At last I concluded it arose from a stink-horn of some kind, and proposed to immediately find the offender. I turned my head for a last look at the beautiful evening primrose, and at that very instant the strange odor filled the air again, coming like a puff of warm breath from the direction of the flowers. Standing still a few moments I felt three more warm puffs, and each time was nearly overpowered by the accompanying smell. Subsequently I had an opportunity of observing the plant a little more closely. I found the puffs were stronger and more frequent on mild, still evenings; that they were then emitted, several in quick succession, at intervals ranging from twenty to thirty minutes. I never watched the plants all night, but have watched from eight in the evening till nearly two in the morning, and found that the puffs were stronger, more frequent and more regular between 9 and 12 P. M. than before or after. The flowers are influenced in opening and closing more by temperature than by the degree of light. When the morning is not too warm, that is to say not over 65° or 70° F., the flowers commonly re-

main open till 10 or 11 A. M. Likewise in the afternoon, when the heat is not too great, they begin to expand about 4 o'clock; at other times they may not open till 6 o'clock. I have taken "wilted" flowers, plucked during the heat of the day, placed their stems in a glass of water and removed the glass to a cool cellar with a northern aspect and plenty of light. In the course of an hour the flowers would slowly open. They seem to be very irregular in their habit. During the middle of the day the petals are wrinkled and loosely folded; the tube droops; the whole flower is limp and seemingly wilted, presenting a sorry appearance.—F. W. ANDERSON, *Great Falls, Montana.*

Some Nebraska plants.—In a recent visit to Clear Water, Neb., I was much impressed and somewhat surprised with the abundance and beauty of the wild flowers. Clear Water is a small town in the northern part of Antelope county, near where a creek of the same name flows into the Elkhorn river. Along the Elkhorn, and also along Clear Water creek, there is some timber, which in that region is deemed a luxury. The most abundant timber is the different species of willow, while the largest and most conspicuous tree is Populus monilifera. Fraxinus viridis, Negundo aceroides and Celtis occidentalis are frequently met with. Juglans nigra was not seen in this immediate vicinity, but it grows quite plentifully on Verdigris creek, in this county. Two shrubs which claimed my attention were Amorpha fruticosa and Shepherdia argentea. The latter is rarely met with. But one clump of these bushes was seen in the county. Amorpha fruticosa is plentiful, and when in flower is a very handsome shrub. Symphoricarpos occidentalis is abundant, and its flowers very pretty, although it is considered a great nuisance by cultivators of the soil. Rhus glabra is occasionally seen, while R. Toxicodendron is too abundant.

One of the first flowers to grace the prairies here in early spring is Townsendia sericea. It usually appears in April, before the spring grass or much other vegetation, which makes it seem prettier than it otherwise would be. Petalostemon villosus is so abundant that seen from a distance when in bloom it gives a rose-colored hue to the prairie. P. violaceus and P. candidus are both here, but not so plentiful as P. villosus. Three species of Pentstemon were noticed, of which P. grandiflora was the most conspicuous. Of the four species of Astragalus which were observed, A. caryocarpus seems to be the most common, and, for some reason, a favorite among the people. Cypripedium candidum, which is thought to be rare in the state, is quite commonly met with here. There is an abundance of wild roses of different hues, all of which belong to the same species, Rosa Arkansana. Two plants, Taraxacum officinale and Cnicus arvensis, which have in the last year or two been introduced, are likely to become great pests to the farmers.—EMMA R. MCGEE, *Clearwater, Neb.*

The clover rust.—*Uromyces trifolii* (A. & S.) Wint. has appeared on

Trifolium pratense in this vicinity in great abundance and is doing much damage. It seems to be most abundant in the aftermath, though it is not confined to the clover of meadows. In many instances the rust is so abundant that the clover leaves are half or more dry and dead. I should say the damage would vary from 5 to 20 per cent. of the value of the clover. So far as I know, the parasite has never been reported on T. pratense from this country before, though it is known in Europe. (*Cf.* Winter, *Die Pilze*, i, 159.) Two years ago it was abundant here on T. hybridum, but this year it seems to have changed to the red clover. T. hybridum is also a new host for America. *Uromyces medicagenis-falcatæ* (DC.) Wint. on Medicago lupulina has been abundant here every year since 1883.—Lucien M. Underwood, *Syracuse University, Syracuse, N. Y.*

Diœcism in Andropogon provincialis.—The Iowa experiment station has been collecting seeds of some of the native prairie grasses for the purpose of testing their value under cultivation. The one regarded as of most promise is *Andropogon provincialis* Lam., called Blue Stem or Blue Joint. At first little or no seed was found on this species; then some plants were noticed which were smaller and darker in color than the others, and so different that they seemed to be a distinct variety. The spikes of these plants proved to be well filled with seed. After this it was seen that wherever Blue Joint was found a small proportion of the plants were of this form. The spikes of these fertile plants ripen and break up earlier than those of the sterile plants. Not all of these, however, have the heads well filled with seed. The sterile plants have conspicuous stamens with abundant pollen, and also large fully expanded stigmas. The division into staminate and pistillate plants is perhaps only partial. Circumstances did not permit a more extended examination at the time, but plants of each form have been marked for future study. It would be well also for others conveniently situated to take notice regarding this feature. If it shall prove to be a permanent habit of this grass to have but few of the individuals fertile it will be a serious difficulty in the way of its profitable cultivation.—A. A. Crozier, *Ames, Iowa.*

EDITORIAL.

The editor of *Grevillea*, in the September issue of that journal, accuses "some of the junior mycologists of the United States" of "committing a dangerous mistake" and of indulging in "spread-eagleism" regarding the identity of certain type specimens. Dr. Curtis collected the series of fungi known as *Herb. Curtis.* The descriptions of the new species were drawn up by Rev. M. J. Berkeley, of England, and published under the joint authority of Berkeley & Curtis. Now some American has

allowed his love of country, so we are to infer, to blind him to the evident fact that where a real difference exists between a specimen in the Curtis herbarium and one in the Berkeley herbarium, it is the latter only which is to be regarded as the type. This is so obviously true that we fear that Mr. Cooke was under some misapprehension when writing his warning. But while the simple statement seems to be beyond controversy, differences may still arise as to the interpretation of the Berkeley & Curtis types. Because a cursory examination appears to make out the type specimen in the Berkeley collection to be different from the corresponding specimen in the Curtis set, it does not necessarily follow that it is really so. It is quite possible that errors might have arisen in the original study, and that the specimen in the Curtis herbarium, although different, might yet be a better representative of the real species than the type specimen itself. There is often internal evidence to show that certain specimens in Herb. Curtis, although in some characters different, are still undoubtedly the same as those in Herb. Berkeley. For instance, if a leaf with a Puccinia has been cut in two and half sent to Rev. Berkeley and half placed in the Herb. Curtis, the description in many respects corresponding to the Curtis plant, but not in others, we are not to infer that there were two distinct things, but rather that the Curtis plant is genuine, and a study of it can show facts not previously brought out. There is so much need of cautious work in determining the species and settling the nomenclature of our fungi that it can not be amiss to point out this possible source of misunderstanding.

CURRENT LITERATURE.

Minor Notices.

THE FLORA of the Santa Barbara Islands is the subject of a paper[1] by Mr. T. S. Brandegee. The author investigated the two largest islands, Santa Cruz and Santa Rosa, and in the paper before us gives a list of the plants found. A comparison is made between this flora and that of the neighboring Santa Inez mountains on the mainland. Of the almost 400 species, nearly 380 may be considered as belonging to the San Diego flora, leaving some ten or twelve endemic species. There are, besides these, some nine or ten species not found on the mainland, but are common to other coast islands.

[1] BRANDEGEE, T. S.—Flora of the Santa Barbara Islands. Reprint from Proc. Cal. Acad. Sci., 2d Ser., Vol. I, Part 2. pp. 201-226. Issued October, 1888.

NOTES AND NEWS.

NEW SPECIES of Saussurea by Franchet, and of Clavaria by Boudier and Patouillard, are described in *Journal de Botanique* (Oct. 4).

PROF. JAS. E. HUMPHREY has been elected to the new professorship of Vegetable Physiology at the Massachusetts State Agricultural Experiment Station at Amherst. He enters upon his work November 1.

IT SEEMS that German colonists in Australia introduced their native fruit trees, such as pears, apples, etc., and although they flowered abundantly, no fruit was produced. Lately another colonist brought bees from Europe and the trees are fruiting well.

A NEW GENUS of Berberidaceæ, from Japan, is described in *Jour. Bot.* (Oct.) by Tokutaro Ito. It perhaps comes between Podophyllum and Diphylleia, and is dedicated to the "Linné du Japon," Ono Ranzan, being called Ranzania. We are also assured of the certain occurrence of Podophyllum peltatum in Japan.

THE MARINE LABORATORY at Wood's Holl, Mass., proposes to extend its facilities the coming year to botanical students and investigators. This is, doubtless, one of the most favored spots for the study of marine vegetation on our Atlantic coast, and opening a well equipped laboratory to botanists is likely to be appreciated.

DR. JAMES CLARK, of England, but now at the Botanisches Institut, Tübingen, Germany, has under way a monograph of the Gentianaceæ, begun at the request of Professor Huxley. He will be greatly obliged to American botanists who will send him material. He especially desires ripe seeds of our native species, even of the common kinds, such as G. Andrewsii. The author aims at much more than a merely systematic study of the group.

A COMPLETE ENUMERATION of all known Uredineæ, arranged according to the orders to which their host plants belong, has been published by Dr. P. Dietel, through a Leipzig firm. It covers forty-eight octavo pages with eight additional pages of index. There is evidence of careful compilation, and the work will be heartily appreciated by all students of the rusts. The author would do good service by also issuing a bibliography of this group of plants.

THE FOLLOWING NOTE from an English scientific (?) periodical, just received, may be of interest to American readers: "Among the wonders of the 'Wild West' that have recently been discovered is a vegetable compass. The American Association for the Advancement of Science publishes in its transactions a report penned by General Abford, of the United States Army, and treating of an extraordinary plant growing wild in the states of Oregon and Texas, the leaves of which point due north and south, and are consequently utilized by belated prairie hunters as convenient substitutes for the magnetic needle. Prof. Gray Meehan, who has examined specimens of this gifted shrub at the request of the Association, defines it as dwarf variety of the osier, named Sylphium Laciniatum." We consider this item a gem worth preserving.